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(54) Insulated liquefied gas tanks

Wärmeisolierte Flüssiggastanks

Réservoirs de gaz liquéfié thermiquement isolés

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Description

The present invention relates to insulated liquefied gas tanks and is concerned with that type of such tank which comprises a gas tank connected to whose inner surface are a plurality of stiffening members and whose outer surface is covered by an insulation layer comprising a plurality of insulation panels, each of which is connected to the tank by one or more support members which are connected to the tank and pass through a hole in the associated panel, the panels being retained in position by fastening members located on the outer ends of the support members.

Liquefied gas ships for transporting liquefied gas, such as LNG, at low temperature typically has the structure shown in Figure 1, which is a diagrammatic transverse sectional view through a liquefied gas ship, in which a tank 1 made of aluminium alloy, whose outer surface is covered with an insulation layer 4, is supported by heat-insulating supports 2 on the bottom of the inner shell 3 of the ship's hull.

The insulation layer 4 comprises a plurality of rectangular insulation panels made of, for example, polyurethane foam. Each of the panels is supported at its four corners by support members, such as rods, extending from the outer surface of the tank 1 and fixed to the tank 1 by tightening a fastening member, such as a nut, on the threaded end of each support member with the interposition of a holding member, such as a washer.

Fixing the panels at their four corners to the tank 1 requires a great number of support members, holding members and fastening members, which results in a high cost and the need for much labour and time in mounting the panels and also in the panels and the support members themselves being stressed when the panels shrink. At joints between the panels, when the tank 1 which is cooled down by the liquefied gas to a very low temperature, shrinks the adjacent panels apply forces to each other at the joints and stresses are likely to occur.

It is the object of the present invention to eliminate the above problems and to provide an insulated liquefied gas tank of the type referred to above in which mounting of the insulation panels is facilitated and the occurrence of stresses at the joints between the panels is prevented.

According to the present invention, a liquefied gas tank of the type referred to above is characterised in that a single mounting member is provided for each panel, that the mounting members are connected to the outer surface of the tank at positions opposite to those of stiffening members, that the support members extend outwardly from respective mounting members, that there is only one hole in each panel which is positioned substantially centrally, that the hole is larger than the support member, that a cylindrical member is provided between each mounting member and the associated panel to protect the latter and that positioned between each panel and the tank is a pad whose width is less than that of the panel and which extends in the direction of the length of the associated stiffening member, whereby the panel is spaced from the tank by a clearance.

Thus in the insulated gas tank in accordance with the present invention the insulation material does not directly contact the support members and a predetermined gap or space is maintained between each support member and the central bore of the associated panel due to the presence of the cylindrical member between the mounting member and the associated insulation panel. Each panel is reliably fixed at one point only substantially at the geometrical centre thereof to the tank without the risk of being damaged due to contact with the support member. By comparison with the conventional method of fixing the panels at the four corners thereof, the number of support members and fastening members required is reduced which contributes to the reduction in cost and to an improvement in the efficiency of mounting the panels. No stresses are produced in the panels since they may contract freely towards the centre thereof, at which position they are fastened to the tank. Portions of the tank wall which are not provided with a stiffening member may be deformed, in use, e.g. corrugated due, for example, to the pressure of the liquefied gas within it. However, due to the fact that the mounting members are fixed to the outer surface of the tank at positions which are opposed to stiffening members on the inner surface of the tank and that a pad narrower than the panel extends along the length of an associated stiffening member and is arranged between the outer surface of the tank and the panel, whereby the panel is connected to the outer surface of the tank with a predetermined clearance therefrom, the panel is not influenced by deformation or corrugation of portions of the tank wall. Thus the panels are subject neither to damage nor to excessive forces applied to the mounting members. Due to the fact that the panels are mounted on the tank body with a clearance, even if liquefied gas should leak from the tank it moves rapidly through the clearance and is collected at a preselected point at the bottom of the insulation.

A holding member, such as a washer, may be interposed between each fastening member and the outer surface of the associated panel.

It is preferred that the support members, holding members and fastening members are all made of materials having high heat insulating properties. This will minimise the rate of heat propagation from the exterior of the tank to the tank body and thereby enhance the insulation of the tank.

It is preferred that at least certain of the joints between adjacent panels comprise a gap of which the portion closer to the tank is narrower than the portion remote from the tank, the narrower gap portion being filled with an insulation material which is elastic at low temperatures, the gap being sealed at the junction of the two gap portions by a boundary tape and an elastic heat insulator being fitted in an airtight manner into the wider gap portion. The heat insulator may occupy substantially all of

the wider gap portion or only part of it. The partition tape will prevent the outflow of cold gas, such as air or nitrogen, which would otherwise tend to escape to the exterior through the insulation material in the narrower portion of the gap under the action of gravity, particularly at the bottom of the tank. The heat insulator reliably blocks the transfer of heat between the exterior and the body of the tank. Shrinkage of the panels and the influence of shrinkage of the body of the tank, which is cooled down by the cold liquefied gas within it, are absorbed by the insulation material and by the heat insulator whereby no stresses are produced in the panels. The joint itself is not damaged since it is soft or resilient.

At the bottom of the tank the heat insulator may occupy that portion of the wider gap portion which is remote from the tank, the remainder of the wider gap portion being substantially occupied by a joint insulation member which is fitted therein in a substantially airtight manner and is made of the same material as the panels and has an elastically deformable portion on one side thereof. In this case, the joint insulation member and the heat insulator reliably prevent the transfer of heat. Shrinkage of the panels and the influence of shrinkage of the body of the tank, which is cooled down by the liquefied gas within it, are absorbed by the insulation material and by the heat insulator and also by the joint insulation member which may expand or shrink whilst maintaining the same heat insulating performance as the panels due to the presence of its elastically deformable portion which is constituted by the same material as the panels. No stresses are thus produced in the panels. If any cold liquefied gas should leak from the tank, this liquid flows into the narrower portion of the gap through the clearance between the tank and the panels so that the joint insulation member is cooled down via the partition tape. However, since the joint insulation member is made of the same material as the panels it does not become detached from the panels as a result of hardening and shrinkage caused by cooling. Even if the liquid should flow out through the partition tape, the integrity of the joint is satisfactorily maintained and the outflow of the liquid to the exterior is prevented.

At the side surfaces of the tank, where the influence of gravity is less than at the bottom of the tank with respect to the outflow of cold gas, the heat insulator may occupy that portion of the wider gap portion which is remote from the tank, the remainder of the wider gap portion being substantially occupied by a joint insulation member which is attached at one side to one of the panels whilst its other side is spaced from the other of the panels, the joint insulation member being made of the same material as the panels. The outflow of cold gas to the exterior is thus again reliably blocked by the partition tape. The joint insulation member is of the same material as the panels and attached at only one side to one of the panels whilst its other side is spaced from the other of the panels. Heat transfer between the tank and the exterior is reliably prevented by the joint insulation member, which is not fitted into the gap in an airtight manner, and by the heat insulator. Shrinkage of the panel and the influence of shrinkage of the body of the tank, which is cooled by the liquefied gas, are absorbed by the insulation material, the joint insulation member and the heat insulator. No stresses are thus produced in the panels.

At the top surface of the tank, where the force of gravity works against the outflow of cold gas to the exterior, the joints between adjacent panels may comprise a gap of which the portion closer to the tank is narrower than the portion remote from the tank, the narrower portion of the gap being filled with an insulation material which is elastic at low temperatures and an elastic heat insulator being fitted in an airtight manner into the wider portion of the gap. In these joints the outflow of cold gas to the exterior is reliably prevented without using partition tape. Heat transfer between the tank and the exterior is reliably prevented by the heat insulator. Shrinkage of the panels and the influence of shrinkage of the body of the tank are absorbed by the insulation material and the heat insulator. Again, no stresses are produced in the panels.

It is preferred that a balance hole passes through the insulation layer, preferably at substantially the highest point thereof, the balance hole connecting the clearance between the tank and the panels with the exterior of the insulation layer. Gas may thus move freely between the clearance and the exterior of the insulation layer through the balance hole if any change in pressure in the clearance should occur, e.g. due to changes in temperature. As a result, the pressure in the clearance is always equal to the pressure outside the insulation layer which prevents deformation of the tank occurring due to an increase in pressure in the clearance. Detaching of the insulation layer from the tank body and a consequent decrease in the insulating effect are thus also prevented. Since the gas moves in and out of the clearance only when the pressure in the clearance changes and the balance hole is provided substantially at the highest position of the insulation layer, cold gas does not flow out of the clearance under the action of gravity and the heat insulating effect is maintained at a high level.

Further features and details of the invention will be more apparent from the following description of one preferred embodiment thereof which is given by with reference to Figures 2 to 8 of the accompanying drawings, in which:-

Figure 2 is an enlarged scrap sectional view of an embodiment of the present invention;

Figure 3 is a view in the direction of the arrows III in Figure 2;

Figure 4 is an enlarged scrap sectional view showing a joint between two insulation panels mounted on the bottom outer surface of the tank;

Figure 5 is a view similar to Figure 4 of a modified

joint;

Figure 6 is an enlarged scrap sectional view showing a joint between insulation panels mounted on an outer side surface of the tank;

Figure 7 is an enlarged scrap sectional view showing a joint between insulation panels mounted on the outer top surface of the tank; and

Figure 8 is a scrap transverse sectional view showing a tank within a ship's hold with an insulation layer with a balance hole.

Referring firstly to Figures 2 and 3, a tank 1 with an elongate stiffening member la mounted on its inner surface has a mounting member 6 fixed thereto by welding at a position on the outer surface of the tank body 1 opposite to the stiffening member 1a. The mounting member 6 is made of aluminum alloy and is formed with a central internal thread 5 into which an externally threaded base end 7 of an elongate support member 9, such as a rod, is screwed, whereby the support member 9 projects outwardly from the mounting member 6. The support member 9 is passed through a central bore 11 in a panel 10 of larger diameter than the support member 9. Interposed between the mounting member 6 and the panel 10 is a cylindrical member or bush 12 for protecting the panel 10. Interposed between the outer surface of the tank 1 and the panel 10 is a pad 13 having a width w narrower than that of the panel 10 and extending longitudinally opposite to the stiffening member la. The support member 9 has an externally threaded tip end 8 on which a fastening member 15, such as a nut, is tightened against the outer surface of the panel 10 with the interposition of a holding member 14, such as a washer, thereby mounting the panel 10 on the outer surface of the tank 1 with a predetermined clearance c corresponding to the thickness of the pad 13. An insulation layer 4 is thus provided on the tank.

In the arrangement described above, the panel 10 is not in direct contact with the support member 9 due to the cylindrical member 12 between the mounting member 6 and the panel 10 and a predetermined gap or space is maintained between the support member 9 and the bore 11. The panel 10 is thus reliably fixed at one point at its centre free of risk of damage due to contact with the support member 9. Compared with the conventional way of fixing the panels at their four corners, the number of support members, fastening members and holding members required is decreased, which contributes to a cost reduction and to an improvement in the efficiency of mounting the panels. No stresses occur in the panels 10 since they may freely contract towards their centre.

Wall surface portions of the tank 1 with no stiffening member 1a may be deformed into corrugations due, for example, to the pressure of the liquefied gas inside. However, because the mounting member 6 is fixed to the outer surface of the tank 1 opposite to the stiffening member 1a and the pad 13, which is narrower than the panel 10 and extends along the length of the stiffening member 1a, and interposed between the outer surface of the tank 1 and the panel 10 and also because the panel 10 is mounted spaced from the outer surface of the tank 1, the panel 10 is not influenced by displacement or corrugation of the wall surface portions of the tank 1. This contributes to the prevention of damage to the panel 10 and the application of excessive force to the mounting member 6.

Because the panel 10 is mounted on the outer surface of the tank 1 with a clearance c, even if liquefied gas should leak from the tank, it moves quickly through the clearance c and is collected at a given point at the bottom of the insulation.

When the support members 9, the holding members 14 and the fastening members 15 are made of a material having a sufficiently high strength and heat insulating property, such as plywood, heat outside the tank 1 is hardly transmitted into the tank 1, which very effectively improves the insulation properties of the tank 1.

The insulating covering of the tank will comprise a plurality of adjacent insulation panels and Figure 4 shows a joint between two insulation panels 10, which are as shown in Figures 2 and 3 and are mounted on the bottom outer surface of the tank 1. The opposed edges of the panels define a relatively small gap 16 adjacent the tank 1, i.e. on the colder side, and a wider gap 18 on the warmer side. An insulation material 17, such as glass wool, which has elasticity at low temperatures, is filled in the gap 16. A partition tape 19 is used to shield the boundary between the gaps 16 and 18. A heat insulator 20 made of, for example, polyethylene foam is fitted in an airtight manner into the gap 18 by attaching opposite sides of the insulator 20 to the adjacent panels 10. Since the heat insulator 20, the insulation material 17 and the panel 10 are respectively made of, for example, polyethylene foam, glass wool and polyurethane foam, the heat insulator 20 has heat insulating properties worse than that of the panel 10 but much better than that of the insulation material 17 and has an elasticity higher than that of the panel 10 at a given temperature near ambient temperature.

At the bottom of the tank 1, cold gas tends to escape to the exterior through the insulation material 17 in the gap 16 under the influence of gravity. However, this flow of cold gas is blocked by the partition tape 19 at the boundary between the gaps 16 and 18. Heat transfer to and from the exterior is reliably prevented by the heat insulator 20 in the gap 18. Shrinkage of the panels 10 and the affect of shrinkage of the tank 1, which is cooled by low-temperature liquefied gas, are absorbed by the insulation material 17 of e.g. glass wool, which has elasticity at low temperatures, and by heat insulator 20 of e.g. polyethylene foam which has a higher elasticity than polyurethane foam at a given temperature near ambient temperature. Therefore, no stresses are produced in the

panels 10 and the joint itself between the panels 10 is not damaged since it is soft.

The joint between the panels 10 shown in Figure 4 has excellent insulation properties and can accommodate shrinking of the tank 1, thereby avoiding stresses in the panels 10.

Figure 5 shows a modified joint which is substantially similar to that shown in Figure 4 except that the gap 18 receives an insulation joint member 22 adjacent to the partition tape 19 and the heat insulator 20 is also arranged in the gap 18 remote from the partition tape 19. The joint member 22, which has an elastically deformable portion 21 on one side and is made of the same material, such as polyurethane foam, as the panels 10, is fitted in an airtight manner into the gap 18 by attaching opposite sides thereof to the adjacent panels 10. The elastically deformable portion 21 is provided by forming a notch 21a and a slit 21b on the one side of the member 22.

Again, cold gas tends to escape to the exterior through the insulation material 17 in the gap 16 under the influence of gravity. However, this flow of cold gas is blocked by the partition tape 19 at the boundary between the gaps 16 and 18. Heat transfer to and from the exterior is reliably prevented by the insulation joint member 22 and the heat insulator 20 in the gap 18. Shrinking of the panels 10 and the effects of shrinkage of the tank 1 are absorbed by the insulation material 17, such as glass wool, by the insulation joint member 22, which can expand or shrink due to the elastically deformable portion 21 and by the heat insulator 20 of e.g. polyethylene foam whose elasticity is higher than that of polyurethane foam at ambient temperature. Therefore, no stresses occur in the panels 10. If low temperature liquefied gas should leak from the tank 1, it moves into the gap 16 through the clearance between the outer surface of the tank 1 and the panels 10 and the joint member 22 is cooled down via the partition tape 19. However, the joint member 22 is not hardened or shrunk and is not detached from the panels 10 since it is of the same material, such as polyurethane foam, as the panels 10. Even if the liquid should flow through the partition tape 19, liquid-tightness can be satisfactorily maintained and the outflow of the leaking liquid to the exterior is prevented.

The joint between the panels 10 shown in Figure 5 thus has similar or enhanced properties and advantages as compared to that shown in Figure 4.

The joint structure shown in Figure 4 or 5 may be applicable not only to the bottom of the tank 1 but also to its sides or top. However, at the side surfaces of the tank 1, influence of gravity on the outflow of cold gas to the exterior is lower than at the bottom of the tank. At the top surface of the tank 1, gravity works against, i.e. in the direction of preventing, the outflow of cold gas to the exterior. Therefore, it is advantageous in terms of efficiency and cost to simplify the joint structure between the panels 10 at the side or top surfaces of the tank 1 as compared with that at the bottom surface.

For this reason, the joints between the panels 10 on the side surfaces of the tank may be constructed as shown in Figure 6. More specifically, an insulation joint member 22 made of the same material, such as polyurethane foam, as the panels 10 is arranged in the gap 18 adjacent to the partition tape 19 such that only the lower side of the joint member 22 is attached to one of the adjacent panels 10 and the opposite side of the joint member 22 is spaced from the other of the panels 10. The heat insulator 20, e.g. of polyethylene foam, is fitted in an airtight manner into the gap 18 by attaching both sides thereof to the adjacent panels 10. A joint between the panels 10 at the top surface of the tank 1 may be constructed as shown in Figure 7 in which the inner portion 16 of the gap, i.e. on the low temperature side, has a height greater than that in the joints shown in Figures 4 to 6. An insulation material 17, such as glass wool, is positioned in the gap 16 while a heat insulator 20 made of, for example, polyethylene foam is fitted in an airtight manner into the gap 18.

The joints shown in Figure 6 operate in a manner similar to that shown in Figures 4 and 5 so that again no stresses are produced in the panels 10. The joint shown in Figure 7 requires no tape 19 since gravity operates to prevent the flow of liquid through the joint but in other respects its function and advantages are the same as in the preceding joints.

As is clear from Figures 4 to 7, a joint structure may be selected which is the most appropriate as regards the position where the panels 10 are mounted and the desired improvement in working efficiency and cost.

When the panels 10 are mounted as shown in Figures 2 and 3 and joints between the panels 10 as shown in Figures 4 to 7 are employed for the insulation layer 4, the airtightness of the gap or clearance c behind the insulation layer is increased and the gap is substantially cut off or isolated from the exterior. Therefore, any increase of the pressure in the clearance c due to, for example, a temperature change or leakage of liquefied gas would cause the tank 1 to be deformed or the layer 4 to be detached from the tank 1, thereby resulting in a reduction in the insulation effect. To overcome this problem, it is preferable to provide a balance hole 24, as shown in Figure 8, passing through the layer 4 and connecting the clearance c with a hold space H outside the layer 4, at substantially the highest position on the layer 4 mounted on the outer surface of the tank 1 (i.e. substantially at the outer periphery of the rising portion of the tank dome 23 of the tank 1). The balance hole 24 is provided with a communicating pipe 25, the outer end of which within the hold space H is bent downward so that its open mouth is at a height L which is about 150 cm above the layer 4 at the top of the tank 1 and which is suitable for inspection. In Figure 8, reference numeral 26 represents the gap between the tank supports 2 and the layer 4 which is filled with an insulation material, such as glass wool. 27 represents a seal, e.g. of tape, for preventing the outflow of cold gas through the gap 26.

When the balance hole 24 is provided at substantially the highest position on the layer 4, as shown in Figure 8, if the pressure in the clearance c is about to vary due to, for example, a temperature change, gas moves freely between the clearance c and the hold space H outside of the layer 4 via the pipe 25 in the balance hole 24. As a result, the pressures in the clearance c and the hold space H are equalised, which prevents deformation of the tank 1, detaching of the layer 4 from the tank 1 and a decrease in the insulation effect. Since the gas moves in and out only when there is a pressure differential and the balance hole 24 is at substantially the highest position on the layer 4, cold gas does not flow out of the clearance c under gravity and a high degree of heat insulation is maintained.

Claims

1. An insulated liquefied gas tank comprising a gas tank (1), connected to whose inner surface are a plurality of stiffening members (1a) and whose outer surface is covered by an insulation layer (4) comprising a plurality of insulation panels (10), each of which is connected to the tank (1) by one or more support members (9) which are connected to the tank (1) and pass through a hole (11) in the associated panel (10), the panels (10) being retained in position by fastening members (15) located on the outer ends of the support members (9), characterised in that one mounting member (6) is provided for each panel (10), that the mounting members (6) are connected to the outer surface of the tank (1) at positions opposite to those of stiffening members (1a), that the support members (9) extend outwardly from respective mounting members (6), that there is only one hole (11) in each panel (10) which is positioned substantially centrally, that the hole (11) is larger than the support member (9), that a cylindrical member (12) is provided between each mounting member (6) and the associated panel (10) to protect the latter and that positioned between each panel (10) and the tank (1) is a pad (13) whose width is less than that of the panel (10) and which extends in the direction of the length of the associated stiffening member (1a), whereby the panel (10) is spaced from the tank (1) by a clearance (c).

2. A tank as claimed in Claim 1 characterised by a holding member, such as a washer (14), interposed between each fastening member (15) and the outer surface of the associated panel (10).

3. A tank as claimed in Claim 1 or Claim 2, characterised in that the support members (9), holding members (14) and fastening members (15) are made of materials having high heat insulating properties.

4. A tank as claimed in any one of the preceding claims, characterised in that at least certain of the joints between adjacent panels (10) comprise a gap of which the portion (16) closer to the tank (1) is narrower than the portion (18) remote from the tank (1), that the gap portion (16) is filled with an insulation material (17), that the gap is sealed at the junction of the gap portions (16, 18) by boundary tape (19) and that an elastic heat insulator (20) is fitted in an airtight manner into the gap portion (18).

5. A tank as claimed in Claim 4, characterised in that the heat insulator (20) occupies substantially all of the gap portion (18).

6. A tank as claimed in Claim 4, characterised in that the heat insulator (20) occupies that portion of the gap portion (18) which is remote from the tank (1), the remainder of the gap portion (18) being substantially occupied by a joint insulation member (2) which is fitted therein in a substantially airtight manner and that the joint insulation member (22) is made of the same material as the panels (10) and has an elastically deformable portion (21) on one side thereof.

7. A tank as claimed in Claim 4, characterised in that the heat insulator (20) occupies that portion of the gap portion (18) which is remote from the tank (1), the remainder of the gap portion (18) being substantially occupied by a joint insulation member (22) which is attached at one side to one of the panels (10) whilst its other side is spaced from the other of the panels (10) and that the joint insulation member (22) is made of the same material as the panels (10).

8. A tank as claimed in any one of the preceding claims, characterised in that the joints between adjacent panels (10) at the top of the tank comprise a gap of which the portion (16) closer to the tank (1) is narrower than the portion remote from the tank (1), that the gap portion (16) is filled with an insulation material (17) which is elastic at low temperatures and that an elastic heat insulator (20) is fitted in an airtight manner into the gap portion (18).

9. A tank as claimed in any one of the preceding claims, characterised in that a balance hole (24) passes through the insulation layer (4) at substantially the highest point thereof, the balance hole connecting the clearance (c) with the exterior of the insulation layer (4).

Patentansprüche

1. Ein isolierter Flüssiggastank, der einen Gasbehälter (1) enthält, mit dessen Innenfläche Versteifungselemente (1a) in einer Mehrzahl verbunden sind und

dessen Außenfläche durch eine Isolierschicht (4) bedeckt ist, die eine Mehrzahl von Isolierplatten (10) umfaßt, von denen jede mit dem Behälter (1) über ein oder mehrere Halterungselemente (9), welche an den Behälter (1) angeschlossen sind sowie durch eine Bohrung (11) in der zugeordneten Platte (10) hindurchgehen, verbunden ist, wobei die Platten (10) in ihrer Lage durch an den äußeren Enden der Halterungselemente (9) angebrachte Spannelemente (15) festgehalten werden, dadurch gekennzeichnet, daß für jede Platte (10) ein einziges Befestigungsteil (6) vorgesehen ist, daß die Befestigungsteile (6) mit der Außenfläche des Behälters (1) an zu den Positionen der Versteifungselemente (1a) gegenüberliegenden Positionen verbunden sind, daß sich die Halterungselemente (9) von jeweils zugeordneten Befestigungsteilen (6) auswärts erstrecken, daß in jeder Platte (10) nur eine Bohrung (11) vorhanden ist, die im wesentlichen zentral angeordnet ist, daß die Bohrung (11) größer ist als das Halterungselement (9), daß zwischen jedem Befestigungsteil (6) sowie der zugeordneten Platte (10), um letztere zu schützen, ein zylindrisches Bauteil (12) vorgesehen ist und daß zwischen jeder Platte (10) sowie dem Behälter (1) ein Einlagestück (13) positioniert ist, dessen Breite geringer als diejenige der Platte (10) ist und das sich in der Längsrichtung des zugehörigen Versteifungselements (1a) erstreckt, wodurch die Platte (10) mit einem Abstand (c) vom Behälter (1) getrennt angeordnet ist.

2. Ein Tank nach Anspruch 1, gekennzeichnet durch ein zwischen jedes Spannelement (15) und die Außenfläche der zugeordneten Platte (10) eingesetztes Halteorgan (14), wie eine Beilagscheibe.

3. Ein Tank nach Anspruch 1 oder Anspruch 2, dadurch gekennzeichnet, daß die Halterungselemente (9), die Halteorgane (14) und die Spannelemente (15) aus Materialien gefertigt sind, die hohe Wärmeisoliereigenschaften haben.

4. Ein Tank nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß mindestens bestimmte der Verbindungen zwischen benachbarten Platten (10) eine Fuge enthalten, deren zum Behälter (1) näherliegender Teil (16) schmaler als der vom Behälter (1) entfernte Teil (18) ist, daß der Fugenteil (16) mit einem Isoliermaterial (17) gefüllt ist, daß die Fuge an der Verbindungsstelle der Fugenteile (16, 18) durch einen Trennstreifen (19) verschlossen ist und daß in das Fugenteil (18) ein elastischer Wärmeisolator (20) in einer luftdichten Weise eingepaßt ist.

5. Ein Tank nach Anspruch 4, dadurch gekennzeichnet, daß der Wärmeisolator (20) im wesentlichen den gesamten Fugenteil (18) einnimmt.

6. Ein Tank nach Anspruch 4, dadurch gekennzeichnet, daß der Wärmeisolator (20) denjenigen Teil (18) der Fuge, der vom Behälter (1) entfernt ist, einnimmt, daß der Rest des Fugenteils (18) im wesentlichen von einem Fugenisolierelement (22), das in diesen in einer im wesentlichen luftdichten Weise eingepaßt ist, eingenommen wird und daß das Fugenisolierelement (22) aus demselben Material wie die Platten (10) hergestellt ist sowie ein elastisch verformbares Teil (21) an seiner einen Seite besitzt.

7. Ein Tank nach Anspruch 4, dadurch gekennzeichnet, daß der Wärmeisolator (20) denjenigen Teil (18) der Fuge, der vom Behälter (1) entfernt ist, einnimmt, daß der Rest des Fugenteils (18) im wesentlichen von einem Fugenisolierelement (22), das an einer Seite an einer der Platten (10) befestigt ist, wogegen seine andere Seite von der anderen der Platten (10) beabstandet ist, eingenommen wird, und daß das Fugenisolierelement (22) aus demselben Material wie die Platten (10) hergestellt ist.

8. Ein Tank nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Verbindungsstellen zwischen benachbarten Platten (10) an der Oberseite des Tanks eine Fuge umfassen, deren zum Behälter (1) näherliegender Teil (16) schmaler als der vom Behälter (1) entfernte Teil ist, daß der Fugenteil (16) mit einem Isoliermaterial (17), das bei niedrigen Temperaturen elastisch ist, gefüllt ist und daß ein Wärmeisolator (20) in einer luftdichten Weise in den Fugenteil (18) eingepaßt ist.

9. Ein Tank nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß eine Ausgleichsöffnung (24) durch die Isolierschicht (4) an deren im wesentlichen höchsten Punkt hindurchgeht, wobei die Ausgleichsöffnung den Zwischenraum (c) mit dem Äußeren der Isolierschicht (4) verbindet.

Revendications

1. Citerne isolée thermiquement pour gaz liquéfié comprenant une citerne à gaz (1), à la surface intérieure de laquelle sont reliés une pluralité d'éléments raidisseurs (1a) et dont la surface extérieure est recouverte par une couche d'isolation (4) comprenant une pluralité de panneaux d'isolation (10), dont chacun est relié à la citerne (1) par un ou plusieurs éléments de support (9) qui sont reliés à la citerne (1) et passont au travers d'un trou (11) ménagé dans le panneau associé (10), les panneaux (10) étant retenus en position par des éléments de fixation (15) situés sur les extrémités extérieures des éléments de sup-

port (9), caractérisée en ce qu'un seul élément de montage (6) est prévu pour chaque panneau (10), en ce que les éléments de montage (6) sont reliés à la surface extérieure de la citerne (1) au niveau de positions opposées à celles des éléments raidisseurs (1a), en ce que les éléments de support (9) s'étendent vers l'extérieur à partir des éléments de montage respectifs (6), en ce qu'il n'y a qu'un seul trou (11) dans chaque panneau (10) qui est positionné sensiblement de façon centrale, en ce que le trou (11) est plus grand que l'élément de support (9), en ce qu'un élément cylindrique (12) est disposé entre chaque élément de montage (6) et le panneau associé (10) afin de protéger ce dernier et en ce qu'est disposé entre chaque panneau (10) et la citerne (1) un tampon (13) dont la largeur est inférieure à celle du panneau (10) et qui s'étend dans le sens de la longueur de l'élément raidisseur associé (1a), d'où il s'ensuit que le panneau (10) est espacé de la citerne (1) par un espace libre (c).

2. citerne selon la revendication 1, caractérisée par un élément de maintien, tel qu'une rondelle (14), interposé entre chaque élément de fixation (15) et la surface extérieure du panneau associé (10).

3. Citerne selon la revendication 1 ou la revendication 2, caractérisée en ce que les éléments de supports (9), les éléments de maintien (14) et les éléments de fixation (15) sont faits de matériaux présentant des propriétés d'isolation thermique élevées.

4. Citerne selon l'une quelconque des revendications précédentes, caractérisée en ce qu'au moins certains des joints entre des panneaux adjacents (10) constituent un interstice (16) dont la partie la plus proche de la citerne (1) est plus étroite que la partie (18) distante de la citerne (1), en ce que la partie d'interstice (16) est remplie d'un matériau d'isolation (17), en ce que l'interstice est rendu hermétique au niveau de la jonction des parties (16, 18) d'interstices par une bande de séparation (19), et en ce qu'un isolant thermique élastique (20) est ajusté de façon étanche à l'air dans la partie (18) d'interstice.

5. Citerne selon la revendication 4, caractérisée en ce que l'isolant thermique (20) occupe sensiblement la totalité de la partie (18) d'interstice.

6. Citerne selon la revendication 4, caractérisée en ce que l'isolant thermique (20) occupe la partie de la partie (18) d'interstice qui est distante de la citerne (1), le reste de la partie (18) d'interstice étant sensiblement occupé par un élément d'isolation de joint (2) qui est ajusté dans celle-ci de façon sensiblement étanche à l'air et en ce que l'élément d'isolation de joint (22) est fait du même matériau que les panneaux (10) et comporte une partie (21) déformable élastiquément sur un premier côté de celui-ci.

7. Citerne selon la revendication 4, caractérisée en ce que l'isolant thermique (20) occupe la partie de la partie (18) d'interstice qui est distante de la citerne (1), le reste de la partie (18) d'interstice étant sensiblement occupé par un élément d'isolation de joint (22) qui est fixé au niveau d'un premier côté à l'un des panneaux (10) tandis que son autre côté est espacé de l'autre des panneaux (10) et en ce que cet élément d'isolation de joint (22) est fait du même matériau que les panneaux (10).

8. Citerne selon l'une quelconque des revendications précédentes, caractérisée en ce que les joints entre des panneaux adjacents (10) au sommet de la citerne constituent un interstice (16) dont la partie la plus proche de la citerne (1) est plus étroite que la partie distante de la citerne (1), en ce que la partie d'interstice (16) est remplie d'un matériau d'isolation (17) qui est élastique aux basses températures et en ce qu'un isolant thermique élastique (20) est ajusté de façon étanche à l'air dans la partie (18) d'interstice.

9. Citerne selon l'une quelconque des revendications précédentes, caractérisée en ce qu'un trou d'équilibrage (24) traverse la couche d'isolation (4) sensiblement au niveau de son point le plus élevé, le trou d'équilibrage reliant l'espace libre (c) à l'extérieur de la couche d'isolation (4).

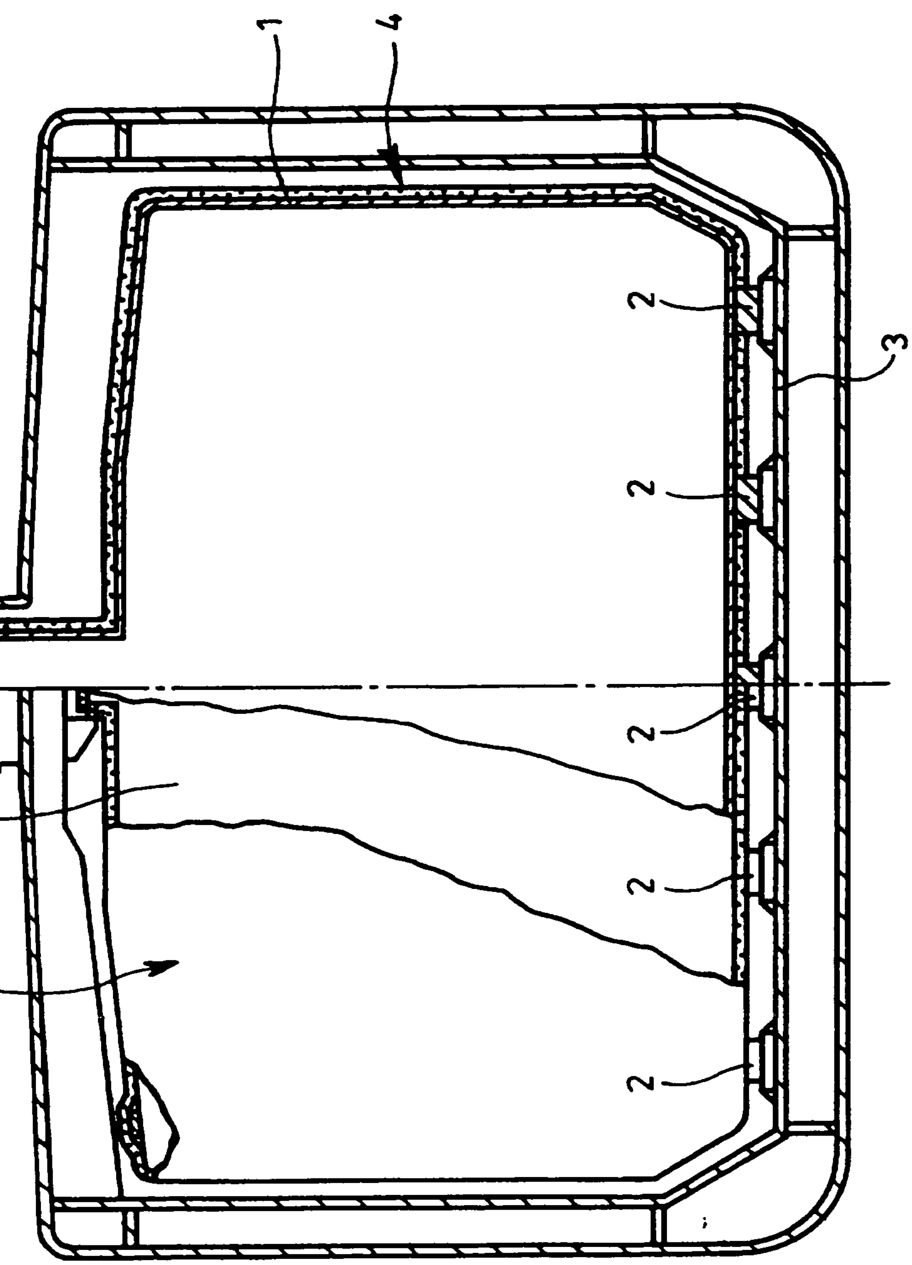

FIG.1

FIG. 2

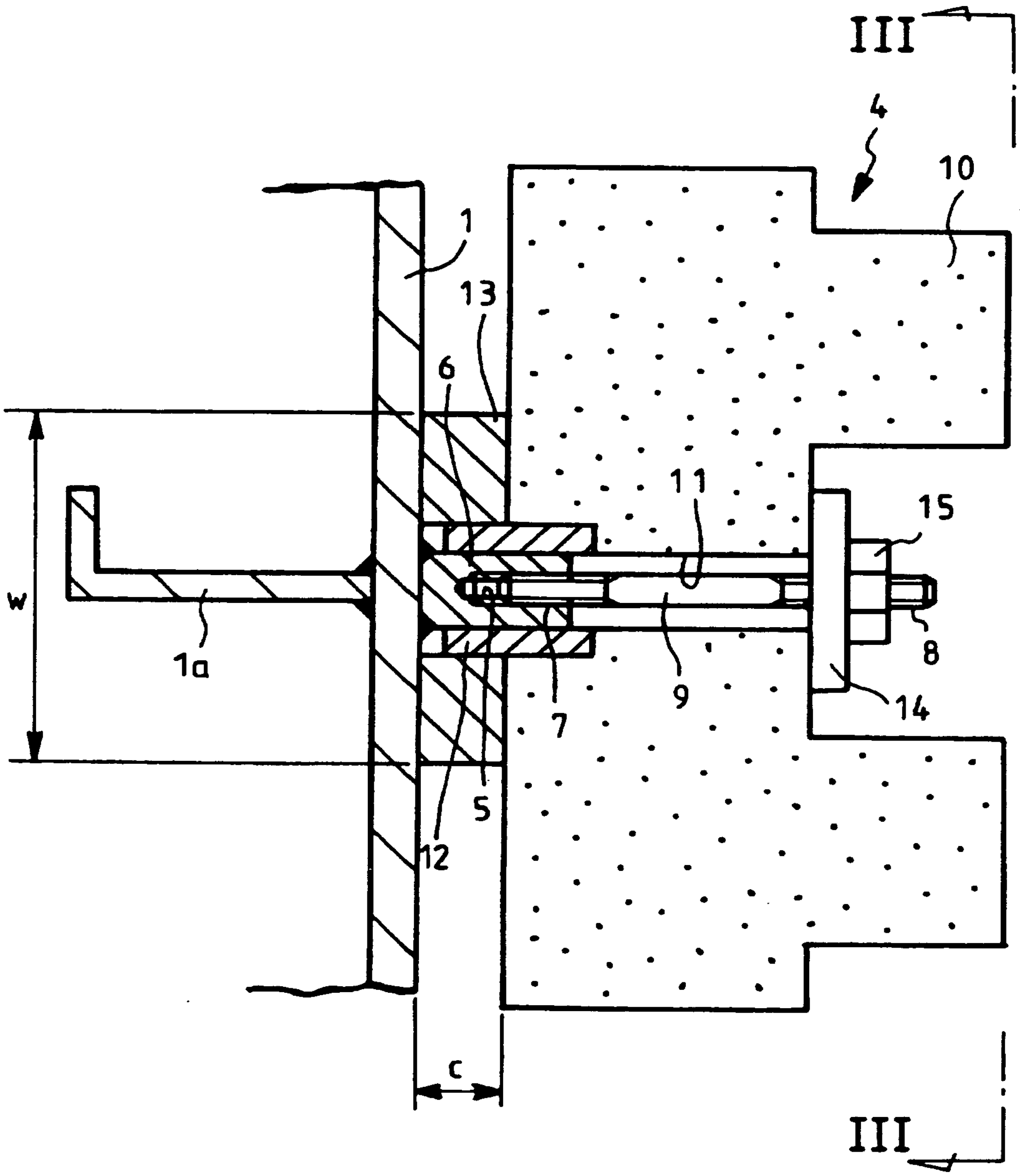

FIG. 3

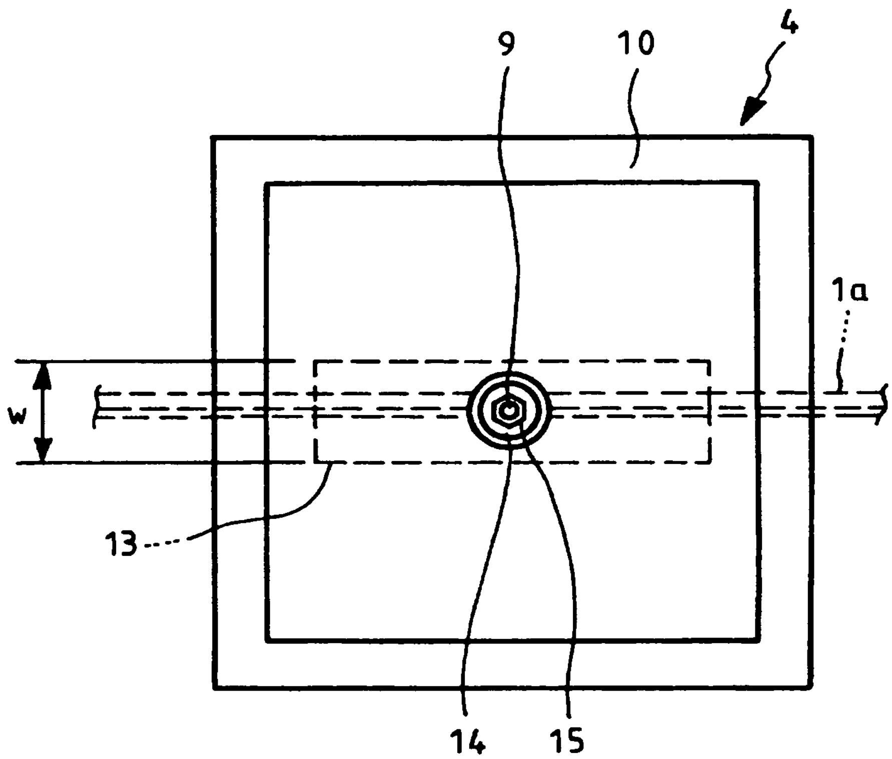

FIG. 4

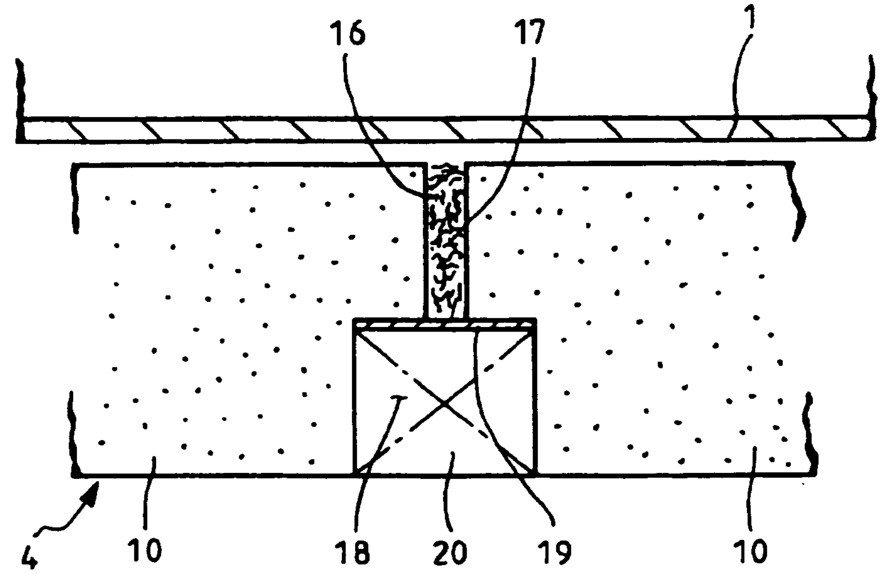

FIG. 5

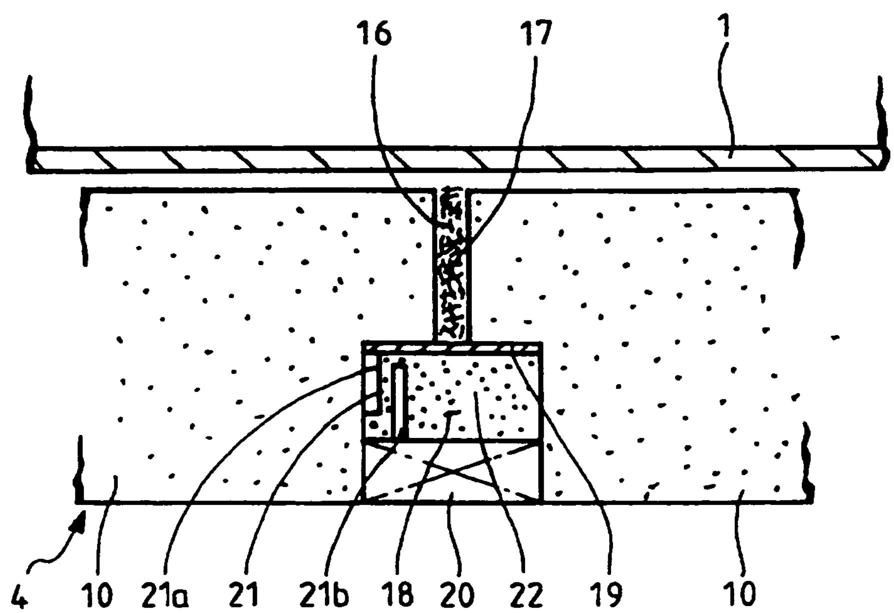

FIG. 6

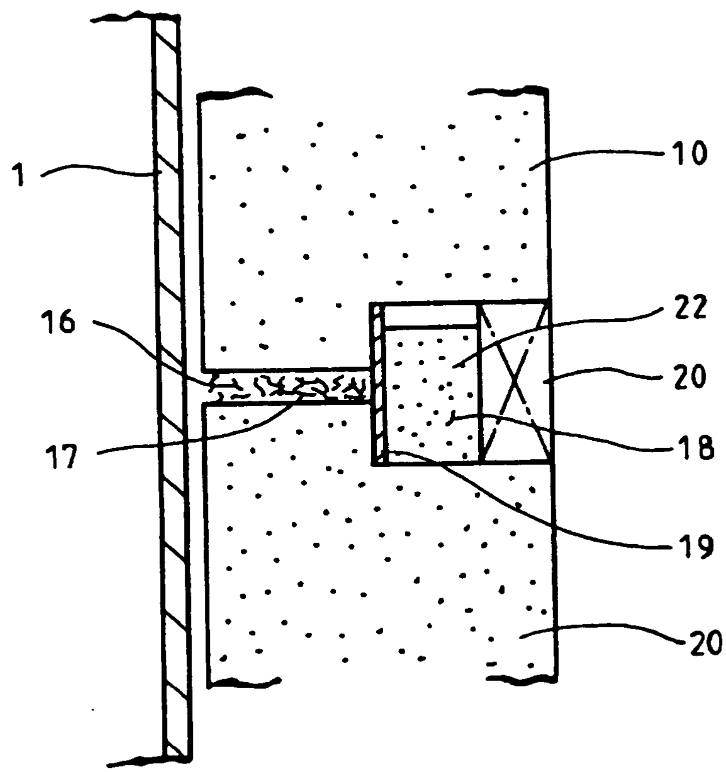

FIG.7

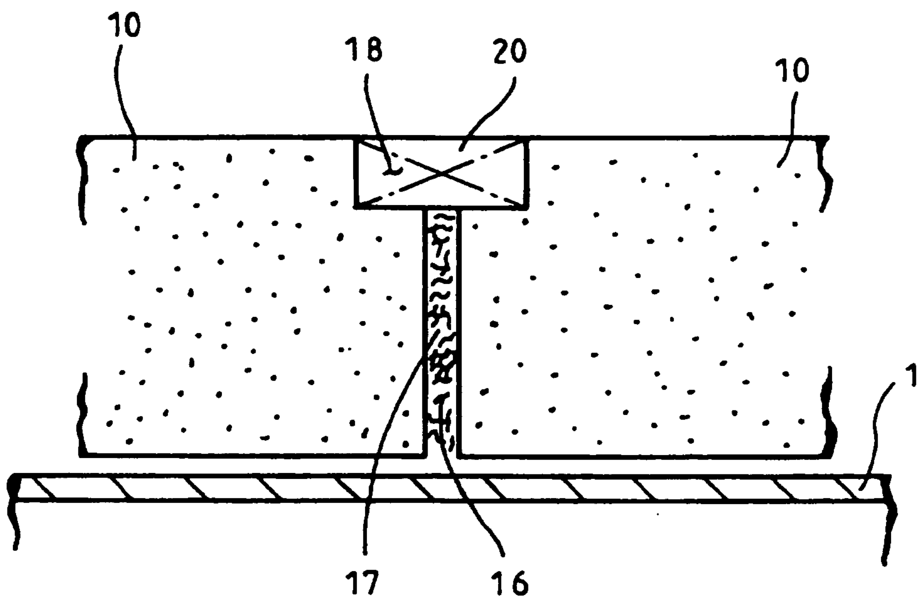

FIG. 8